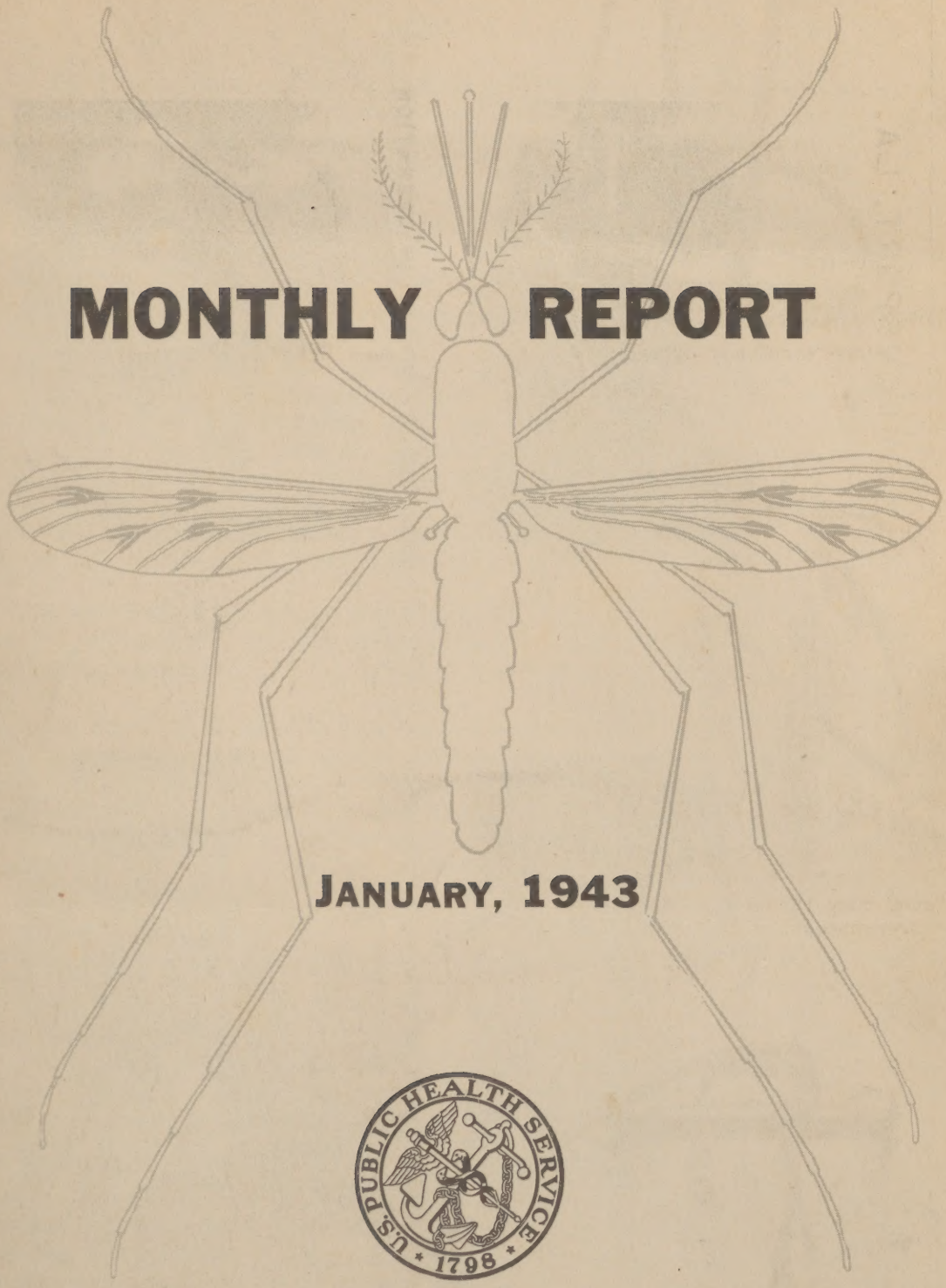
MALARIA CONTROL IN WAR AREAS



MONTHLY REPORT

JANUARY, 1943

FEDERAL SECURITY AGENCY
U. S. PUBLIC HEALTH SERVICE
ATLANTA, GEORGIA

WATER HYACINTH REMOVAL near SHREVEPORT, LA.

POND COVERED WITH WATER HYACINTH

UNDERWATER CUTTER IN OPERATION

CLOSEUP OF UNDERWATER CUTTER

POND CLEARED OF WATER HYACINTH

Photographs by U.S. Army

U.S. Public Health Service
Malaria Control in War Areas

MONTHLY REPORT
Malaria Control in War Areas
January, 1943

SYLLABUS

Minor drainage, ditch clearing and cleaning was continued in 105 areas in preparation for the coming larvicidal season. Ten new War Areas in Louisiana and Tennessee were surveyed and larvicidal project proposals will soon be prepared for six of them. During the coming season, airplane dusting control operations in the water chestnut infested area on the Potomac River will be directed by an engineer from the Headquarters Office. An entomologist from the Headquarters Office will be assigned to the program who will coordinate the entomological work which will be carried on by Virginia, Maryland and the District of Columbia to guide and determine the effectiveness of the dusting operations.

Nine more major drainage project proposals from seven states were reviewed and approved. Forty-two projects were in operation in January, an increase of five over December. Elimination of about 466 acres of water surface by drainage this month should effect a saving of approximately 14,500 man days of labor per season for larvicidal work. Responsibility was assumed by MCWA for the continuance of a number of projects formerly operating under W.P.A. in the extra-cantonment areas of War establishments.

Entomological field work consisted of summarizing the past season's records, revising the station set-up in various areas, making observations on anopheline hibernation and conducting preliminary surveys in new War Areas.

A budget of $100,000 has been tentatively agreed upon for carrying on an expanded Community Education Program during 1943. The Headquarters Office has arranged to furnish personnel and materials to the Malaria Investigations Laboratory in Columbia, South Carolina to make malaria blood slides to supply study material for medical colleges and other groups teaching tropical medicine. About 15,000 to 20,000 of these slides will be made.

Steps were taken this month to simplify and hasten procurement of equipment. An arrangement was made whereby preference ratings may now be secured within one week to ten days and, in case of emergency, can be handled by telegram in even less time.

Twenty-five entomologists were commissioned in January, largely in the Assistant Grade. In addition, five engineers and one biologist were commissioned in the Assistant Grade.

In Key West, Florida the general breeding index for Aedes aegypti dropped to a record low of 1.31%. The first complete inspection of the five new control zones added last month to the Miami, Florida area revealed indices well below 1.0% in every zone. Sealing, filling and mosquito-proofing cisterns and water storage tanks constituted the principal activities of the Aedes aegypti control program in Texas.

Approximately $485,000 of Public Health Service funds were encumbered during January. About 85% of this amount was for personal services.

TABLE I

MALARIA CONTROL IN WAR AREAS

USPHS LARVICIDE AND MINOR DRAINAGE PROJECTS

January 1 - 31, 1943

STATE	Areas in Operation	War Establishments Protected	LARVICIDAL WORK			OTHER WORK			Total Man Hours	Total Men Employed
			Larvicide Used		Surfaces Treated	Ditching & Cleaning Lin.Ft.	Clearing			
			Oil Gals.	Paris Green Lbs.	Acres		Ditches Lin.Ft.	Ponds Acres		
Alabama	4	25	---	---	---	9,890	26,000	.4	5,479	33
Arkansas	10	36	---	---	---	43,540	85,267	140.9	22,211	138
California	2	4	814	---	.5	47,273	---	8.0	2,187	12
D. C.	1	17	---	---	---	9,401	---	---	3,172	19
Florida	10	58	---	---	---	153,390	22,162	16.8	33,619	186
Georgia	10	57	---	41	38.4	39,357	111,530	41.4	20,990	117
Illinois	1	10	---	---	---	---	---	6.5	1,052	6
Indiana	1	4	---	---	---	2,700	---	.5	904	4
Kentucky	3	16	---	---	---	7,586	---	6.7	3,232	38
Louisiana	8	42	7,402	---	585.0	185,284	51,585	121.2	64,493	417
Maryland	2	7	---	---	---	9,340	---	1.6	3,864	23
Mississippi	6	9	---	---	---	41,482	8,125	21.8	11,689	80
Missouri	3	14	---	---	---	4,050	3,300	1.6	1,846	14
North Carolina	8	48	---	---	---	92,004	2,600	71.5	26,715	164
Oklahoma	2	10	---	---	---	---	---	39.9	2,998	24
Puerto Rico	6	17	315	6,136	2722.5	285,560	136,541	3.9	51,572	338
South Carolina	2	43	---	---	---	15,876	---	0.1	6,846	57
Tennessee	8	40	---	---	---	46,911	34,014	17.1	11,895	70
Texas	14	153	8,077	10	287.1	401,816	217,838	91.6	50,864	291
Virginia	4	21	---	---	---	67,069	923,763	11.0	18,778	152
Total	105	631	16,608	6,187	3,633.5	1,462,528	1,622,725	602.3	344,406	2,183
December Total	104	631	52,781	7,672	7,762.1	1,689,500	1,446,304	641.7	346,835	2,364
Total July 1 - January 31	---	---	1,392,912	83,021	123,661.2	13,827,061	22,752,302	6,220.7	2,890,604	---

TABLE II

MALARIA CONTROL IN WAR AREAS

USPHS MAJOR DRAINAGE PROJECTS

January 1 - 31, 1943

STATE	No. of Projects	Clearing Brushing Acres	Channel or Ditch Cleaning Lin. Ft.	New Ditching		Fill	Ditch Lining		Underground Drains Lin.Ft.	Water Surf. Eliminated Acres	Total Man Hours
				Lin.Ft.	Cu.Yds.	Cu.Yds.	Sq.Ft.	Lin.Ft.			
Alabama	3	2.9	600	7,750	3,429	---	---		---	5.2	11,473
Arkansas	1	4.9	---	---	---	---	---		---	---	1,669
Illinois	2	0.4	7,630	1,490	---	---	---		---	2.5	2,448
Kentucky	2	0.3	1,500	5,800	1,311	---	---		---	---	6,302
Mississippi	5	2.0	2,200	9,229	2,522	3,136	---		---	8.9	10,117
Missouri	2	2.5	---	1,100	505	---	---		---	---	2,928
North Carolina	4	7.4	23,125	19,328	7,216	2,535	---		---	19.5	19,563
Oklahoma	1	---	---	---	---	---	---		---	---	2,068
Puerto Rico	2	0.4	1,700	800	1,112	---	---		---	---	19,557
South Carolina	16	96.9	65,928	23,691	10,843	120	---		---	81.1	64,549
Tennessee	1	---	---	1,800	550	---	---		---	5.0	960
Virginia	1	1.6	5,209	5,470	---	---	---		---	344.0	2,540
Total	40	119.3	107,892	76,458	27,488	5,791	---		---	466.2	144,174
December Total	37	177.79	132,863	57,150	15,345	4,983	---		---	109.93	120,742
Total July 1 - January 31	--	588.85	1,027,277	246,208	200,834	20,541	---		---	715.5	453,866

TABLE III

MALARIA CONTROL IN WAR AREAS

NUMBER OF PERSONNEL ON DUTY ON JANUARY 31, 1943 AND TOTAL PAYROLL FOR MONTH OF JANUARY

STATE	TYPE OF PERSONNEL												Percent of Total	
	Commissioned		Prof. & Sci.		Sub-Prof. (1)		C. A. F.		Custodial		Total			
	No.	Pay	No.	Pay	No.	Pay	No.	Pay	No.	Pay	No.	Pay	No.	Pay
Alabama	1	285	5	1,245	2	316	2	390	50	10,467	60	12,703	1.7	3.1
Arkansas	1	285	5	983	12	2,052	4	562	157	16,222	179	20,104	5.2	4.9
California	---	---	2	406	5	1,105	2	440	12	2,038	21	3,989	0.6	0.9
D. C.	1	285	1	325	2	346	2	416	15	1,949	21	3,321	0.6	0.8
Florida	1	285	9	1,903	9	2,492	4	683	175	18,246	198	23,609	5.8	5.7
Georgia	---	---	5	1,125	26	4,787	5	725	87	10,970	123	17,607	3.6	4.3
Illinois	---	---	3	591	3	629	3	610	18	1,821	27	3,651	0.8	0.9
Indiana	1	285	1	167	---	---	1	120	4	443	7	1,015	0.2	0.2
Kentucky	---	---	5	1,083	8	1,083	3	457	50	5,650	66	8,273	1.9	1.9
Louisiana	3	840	10	2,106	30	5,576	4	652	403	49,353	450	58,527	13.1	14.1
Maryland	---	---	---	---	3	521	2	337	20	2,427	25	3,285	0.7	0.8
Mississippi	2	661	3	665	15	2,323	2	373	132	14,409	152	18,431	4.4	4.5
Missouri	1	285	5	1,108	6	1,145	1	156	28	2,577	41	5,271	1.2	1.3
North Carolina	1	247	9	2,412	9	1,610	3	457	293	30,990	315	35,716	9.2	8.6
Oklahoma	1	285	4	867	5	957	1	120	33	4,138	44	6,367	1.3	1.5
Puerto Rico	4	*	2	*	9	*	7	*	428	*	450	22,563	13.1	5.5
South Carolina	2	582	5	1,133	22	4,224	3	487	419	45,781	451	52,207	13.1	12.6
Tennessee	2	570	3	650	7	1,250	2	552	75	7,592	89	10,414	2.6	2.5
Texas	1	285	8	2,044	35	5,568	4	527	262	29,427	310	38,951	9.0	9.4
Virginia	---	---	4	1,017	7	1,155	2	352	113	15,721	126	18,245	3.7	4.4
Aedes aegypti														
Florida	---	---	1	293	79	10,708	3	416	26	3,385	109	14,802	3.1	3.6
South Carolina	---	---	1	155	13	2,032	1	133	4	347	19	2,667	0.5	0.7
Texas	---	---	4	755	9	1,575	1	120	6	749	20	3,199	0.8	0.8
H.Q. & Dist. (2)	25	8,627	12	2,985	27	5,952	68	10,765	7	907	139	29,236	4.0	7.0
Total	47	13,807	107	24,018	341	58,406	130	19,750	2,817	275,609	3,442	414,153		
Percent of Total	1.3	3.5	3.1	6.1	9.9	14.9	3.8	5.1	81.9	70.4	100.0	100.0	100.0	100.0

* Figures not available
(1) Includes Entomological Inspectors
(2) Includes Headquarters and District offices, malaria survey, special investigations and employees temporarily attached to Headquarters pending assignment to States.

MONTHLY REPORT
Malaria Control in War Areas
January, 1943

Larvicidal work declined still further in January, but minor drainage, ditch clearing and cleaning continued in 105 areas in preparation for the coming larvicidal season. Field surveys were made of ten new War Areas in Louisiana and Tennessee. Larvicidal project proposals for the coming season will soon be prepared for one of these areas in Tennessee and five areas in Louisiana. Table I presents data on the larvicidal-minor drainage program for January together with comparative totals for December and the grand totals from July 1 to January 31. Table III shows the data on number of employees and the payroll for the month.

A special arrangement has been made for handling the airplane dusting operations for Anopheles quadrimaculatus control in the water chestnut infested area adjacent to War establishments on the Potomac River below Washington. The area to be covered includes parts of five MCWA areas in Virginia, Maryland and the District of Columbia but can best be treated as a unit. An engineer from the Headquarters Office will direct these operations and an entomologist from the Headquarters Office will coordinate the entomological inspection service which is to be carried on by Virginia, Maryland and the District of Columbia to check on the effectiveness of the dusting operations.

Major Drainage - During January nine project proposals from seven states with an estimated cost of $67,065.00 were reviewed and approved. A total of eighty project proposals have now been reviewed by the Headquarters Office and sixty-one, totaling $1,209,116.00, have been approved. By the end of January, forty-two major drainage projects were operating, an increase of five over December. The progress of major drainage work in January is shown in Table II, together with cumulative figures on major drainage projects from July 1 to January 31. The 466 surface acres of water eliminated this month should effect a saving of some 14,500 man days of labor for larviciding this coming season when the labor situation is expected to be much more serious than it is now.

An example of the economy and advantage of using dynamite in major drainage work came to light in Arkansas this month. This particular project was operating in a swamp which was practically inaccessible to any type of mobile equipment. A small crew using dynamite removed 20,000 cubic yards of excavation and constructed 6,000 linear feet of ditch at a total cost of $8,000.00. It is estimated that, even if it had been possible to use a dragline in the swamp, the job would have cost approximately $20,000.00.

Most of the malaria mosquito control drainage projects operating under W.P.A. have been discontinued in preparation for termination of the Work Projects Administration the first part of February. In accordance with the agreement made in December with the W.P.A. and the Fourth Service Command, MCWA has taken over a number of these projects operating in the vicinity of military establishments. These projects will be carried on under the same general policies and limitations as now govern other MCWA drainage work. A number of the W.P.A. projects have been found to be unjustified as MCWA work either because of the absence of malaria mosquito breeding or because of their distance from War establishments. These have been suspended.

Monthly Report

January, 1943

Entomology - Regular inspection service was maintained in a few areas in Texas and Louisiana and Puerto Rico where active breeding was found and larvicidal operations were being carried on. Other field work consisted of summarizing the past season's records, revising the station set-up in various areas, making observations on anopheline hibernation and conducting preliminary surveys in new War areas where malaria control may become necessary this coming season.

Summaries of light trap collections for the past year have resulted in establishing new records for certain species in the states indicated below:

Mississippi: Aedes atlanticus, dupreei, mitchellae, sticticus, Anopheles georgianus, walkeri, Culex pilosus, salinarius, tarsalis, Mansonia perturbans, Theobaldia melanura and Uranotaenia lowii.
Louisiana: Anopheles georgianus and Psorophora horrida.
Florida: Anopheles georgianus and Culex tarsalis.

Educational Program - A budget of $100,000.00 has been tentatively agreed upon for conducting an expanded Community Education program this season. (A special article on the work of this program appeared in the December, 1942 MCWA Monthly Report.)

Representatives from the Headquarters Office conferred with Assistant Surgeons General Mountin and Coffey in Washington concerning the advisability of proceeding with an enlarged program for preparation of visual educational materials to be used in MCWA training work, and authorization was received to go forward with this proposal. Excess footage of malaria film was obtained from T.V.A. for editing and making technical shorts. The T.V.A. film "Malaria" was loaned to several states for training purposes this month.

A distribution center has been established at the Army Medical School to supply materials for teaching tropical diseases to all medical schools and other professional study groups. This office is furnishing personnel and materials to the Malaria Investigations Laboratory in Columbia, South Carolina, for the preparation of enough blood slides of all three types of malaria to supply all groups in this country with suitable study material. A total of 15,000 to 20,000 slides will be made.

Blood Slide Survey - Plans for collecting information on sub-zones around the various control areas were presented to the MCWA directors in North and South Carolina and Virginia. The work is now going forward in these states as well as in Alabama, Arkansas, Florida, Mississippi and Texas where such work was started earlier.

Equipment - The method of obtaining preference ratings under the Government Requirements Plan of quarterly allotments has been greatly simplified. An arrangement has been made whereby a rating can be obtained within a week to ten days and, in case of emergency, in even less time. This applies to all ratings up to and including AA-5 on items having a unit cost under $100.

The use of heavy construction equipment in major drainage work is increasing. One dragline is now in operation in South Carolina and contracts are awaiting approval for the rental of two additional ones for use in Arkansas and North Carolina. The Headquarters Office is making every effort to learn the location and availability of any useful construction equipment.

Through the efforts of the Office of the Surgeon General, twenty transits and five levels were transferred to Malaria Control in War Areas from the W.P.A. Lack of such equipment has delayed the preparation of drainage plans in some areas and new instruments are virtually unobtainable. Consequently the acquisition of these instruments removed a serious bottleneck.

Personnel - The most significant development in personnel during January was the commissioning of twenty-five entomologists. This is the first group of entomologists commissioned by the Public Health Service. District and State Entomologists now on duty with Malaria Control in War Areas comprised the major portion of this newly commissioned group. Five engineers and one biologist were commissioned in the Assistant Grade. Four engineers were recruited and appointed on Civil Service status.

Recruitment efforts are directed along two major lines, namely, (1) qualified persons not subject to Selective Service call (2) qualified applicants for Reserve Commissions.

Aedes aegypti Control - In Key West, Florida, the Aedes aegypti general breeding index dropped to a record low of 1.31%. A breakdown of the general index showed 0.52% of the premises with exterior breeding, 0.82% with interior breeding and 0.03% with both exterior and interior breeding. These indices were based on meticulous exterior and interior inspections of over 8400 premises. The first completed inspection of the five new control zones added last month to the Miami, Florida area revealed indices well below 1.0% in every zone. Dry weather helped to reduce the general breeding index in the City of Miami to 2.4%.

In Houston, Texas the job of sealing some 450 abandoned cisterns was completed with an average cost of 35¢ per cistern for materials. Sixteen cisterns were sealed and four filled in Galveston during the month, but the problem is more difficult and much more expensive here than in Houston. The Galveston cisterns usually have top openings of 25 to 400 square feet or more and generally are located under houses. Sealing is almost a major construction job; filling requires many truckloads of sand. In Brownsville, forty-one cisterns were sealed and, in addition, ten above-ground water storage tanks were mosquito-proofed.

Expenditures - Some $485,000 of Public Health Service funds were encumbered during January. The approximate amounts were as follows:

.01 Personal Services	$414,100
.02 Travel	15,360
.03 Transportation	1,000
.04 Communication Services	1,630
.05 Rents and Utility Services	1,180
.06 Printing and Binding	150
.07 Other Contractual Services	1,420
.08 Supplies and Materials	39,200
.09 Equipment	11,000
Total	$485,040

LARVICIDES AND THEIR APPLICATION

Part I - Contact Poisons - In January Report
Part II - Stomach Poisons - In February Report
Part III - Application of Larvicides - In February Report

Part I - CONTACT POISONS

The application of larvicides is the primary method of mosquito control used in the program Malaria Control in War Areas. Although this is somewhat contrary to the usual practice in normal malaria control operations in which main reliance is placed on control by drainage and filling, the emergency nature of this program and the temporary character of the establishments being protected, made it advisable to use larvicides to control mosquito production where effective control can be achieved by such measures.

Control by larvicides is based on the fact that the larval and pupal stages of mosquitoes are spent in water and that during these stages the immature mosquitoes must rise periodically and penetrate the surface of the water with their breathing openings in order to obtain oxygen for respiration. The larvae, in addition, obtain their food from among the particles lying on the surface of the water, in suspension in the water, or on the bottom. Larviciding consists of the addition of toxic materials to the breeding waters so that the larvae and pupae will be killed in the performance of these functions.

There are, in general, two types of larvicides:

1. Contact poisons, which kill upon contact with the external and certain internal tissues of the insect.
2. Stomach poisons, which must be ingested to exert a toxic effect.

PETROLEUM OILS

Petroleum oils are the most widely used larvicides for mosquito control. The oil, sprayed over the surface of the water, forms a film there which serves to kill the larvae and pupae breeding underneath.

For best results the oil should possess the following properties:

1. It should readily penetrate the larval and pupal breathing openings and kill the larvae and pupae within a short time after application.
2. It should spread rapidly on the water surface in order to penetrate all the hiding places of the larvae and pupae and produce a uniform, unbroken film on the entire surface.
3. It should form a relatively stable film.

A mosquito larva or pupa, while in the process of breathing on the water surface, will also draw some oil from the surface film into its respiratory system through the breathing opening. The toxic effect then exerted varies with the type of oil used. Oils of low boiling range and high volatility exert a direct toxic action within a very short time. A high boiling, nonvolatile, heavy oil, on the other hand, may slowly cause death within one or two days. In order to be effective, the latter type of oil must be present as a continuous, unbroken film over the surface of the water for a considerable period of time; a condition almost impossible to insure under field operating conditions.

The ideal oil, then, should contain enough of a low boiling petroleum fraction to insure quick penetration into the respiratory system and high toxicity, and a sufficient quantity of a high boiling fraction to leave a relatively stable film. Such an oil would have the following specifications:

Type of Oil	Light Distillate fuel or Diesel
Gravity (A.P.I.)	27-33
Flash Point	130° or higher
Viscosity S.U.	
(a) 100° F.	35-40

Distillation:

10%:	430° -450° F.----(killing fraction)
50%:	510° -550° F.
90%:	630° -F. or higher----(lasting fraction)

These specifications are quite similar to those used by the Navy Department for their Diesel engine oil. The usual No. 2 fuel and Diesel oils are also satisfactory for the purpose.

The use of waste crankcase and similar oils has been found to be quite unsatisfactory. Such oils generally are not very toxic to mosquito larvae and pupae, spread poorly on the water surface and leave an unsightly mess. When mixed with kerosene and sprayed over the water surface, the effect is not much greater than would be produced by the same amount of kerosene used alone. The sludge, and other suspended particles in crankcase oils will clog the nozzles of the sprayers so frequently that the average oiler will soon discard parts of the nozzle so that it will emit a solid stream rather than a spray of oil. Should it become necessary in any area to use waste crankcase oil, it should be collected and stored well in advance of use, so that the sludge and suspended matter will settle to the bottom and the relatively clear supernatant oil can then be drawn off for use.

Generally, from five to fifty gallons of oil per acre are required, depending on the method of application and the amount of vegetation, flotage, and debris. Less oil per unit area is required for the control of anophelines than for pest mosquitoes. Except in a densely overgrown area where larger quantities are necessary, no more than 25 gallons of oil per acre should be used for malaria mosquito control.

Advantages

1. Cheap (in normal times.)
2. Readily obtainable (in normal times.)
3. Can be stored indefinitely.
4. Is relatively long lasting.
5. Can be used in certain situations where pyrethrum-kerosene emulsion is not effective.
6. Is effective against the larvae and pupae of both anopheline and culicine mosquitoes, excepting Mansonia perturbans.

Disadvantages

1. Requires considerable storage space and is messy and bulky to handle.
2. Cannot ordinarily be applied at any considerable distance from the sprayer.
3. Spreads poorly in vegetation or debris; much of it is wasted on the surface of emergent vegetation when such is present.
4. Destructive to the rubber hose and gaskets of the sprayer unless special equipment is used.
5. Is often objected to by wild life interests.

PYRETHRUM-OIL EMULSION

Under certain circumstances, as in ornamental ponds, fish ponds and drinking water supplies where oil or paris green is objectionable, it may be desirable to use a pyrethrum-oil emulsion for control. By the addition of pyrethrum to the oil, it is possible to apply a considerably thinner film of oil to the water surface and still obtain a successful kill.

Pyrethrum powder is the ground dried flowers of the plant Chrysanthemum cinerareafolium. The active toxic ingredient of these flowers is the pyrethrins content; this is

generally extracted from the flowers in kerosene or light oil. The stock emulsion of the pyrethrum-oil emulsion, as developed at the New Jersey Agricultural Experiment Station, contains the following ingredients:

1. Six gallons of kerosene or light oil containing 1140 cc. or 40 ounces of 2% pyrethrum extract in light oil.
2. Three gallons of water.
3. Six ounces of an emulsifying agent, sodium lauryl sulphate (Gardinol W.A. Concentrated) which is commonly used, or 24 ounces of liquid 40% potash soap.

To prepare this emulsion, the emulsifying agent is added to the water, which is agitated until foam begins to form. The light oil, into which the pyrethrum extract has been introduced, is then slowly added to the water, while continuing the agitation. Very violent and sustained agitation is required for the formation of a suitable emulsion; agitation by hand is not usually very satisfactory. The resultant solution constitutes the concentrated stock emulsion in which form the material may be stored. Before spraying, the stock solution is diluted with ten parts of water to each part of emulsion. The diluted emulsion is then sprayed at the rate of about fifty gallons per acre, more or less, depending on the breeding place.

Advantages

1. Is not messy and is acceptable to many property owners where oil is not; for example, to control breeding in outdoor swimming pools.
2. Will not injure vegetation in ornamental garden pools.
3. Not injurious to fish or bird life as normally applied; consequently, more acceptable to wild life interests.
4. Acts much more rapidly than oil, and like oil, is effective against both anophelines and culicines.
5. Can be stored and carried into the field in concentrated form and diluted just before spraying.

Disadvantages

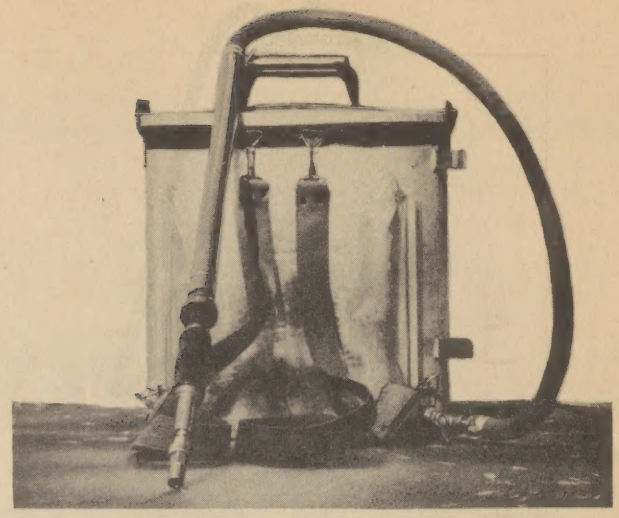
1. Relatively short lasting; quickly loses toxic effect after spraying.
2. Of no value on highly polluted breeding places; toxic effect of both pyrethrum and kerosene rapidly destroyed by high organic content of such places.
3. Special mixing apparatus and care are essential to form a good emulsion.
4. Deteriorates somewhat upon storage, losing some of its toxic qualities; emulsion is permanently destroyed if it is frozen.
5. We are dependent upon a foreign source of supply for pyrethrum.
6. On hot sunshiny days in hot climates it is thought to lose its toxicity in a matter of seconds when used as a fine spray.

PHENOL LARVICIDE

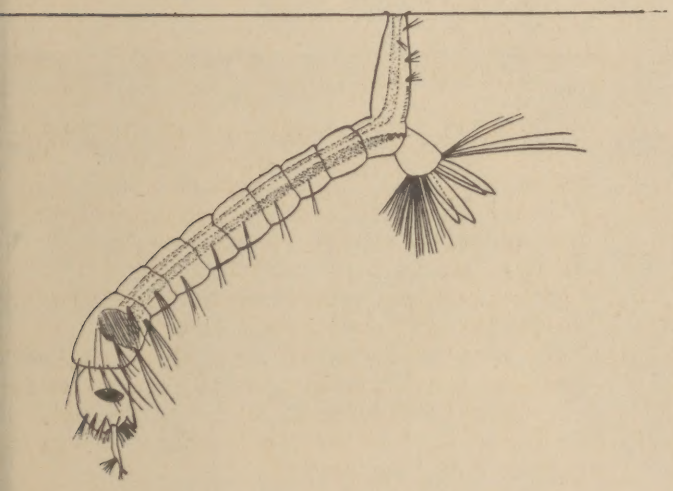
These larvicides are purchased as prepared commercially with varying phenol coefficient. A phenol coefficient of ten to fourteen has been found most suitable for mosquito control work.

The concentrated larvicide is diluted with thirty parts of water before spraying. Applied at rates varying from 10 to 95 gallons per acre, this material was found to be less effective than kerosene. In the laboratory, the larvicide applied at the rate of 50 gallons per acre killed 100 per cent of fish but only 16 per cent of larvae. It is therefore not recommended for general mosquito control.

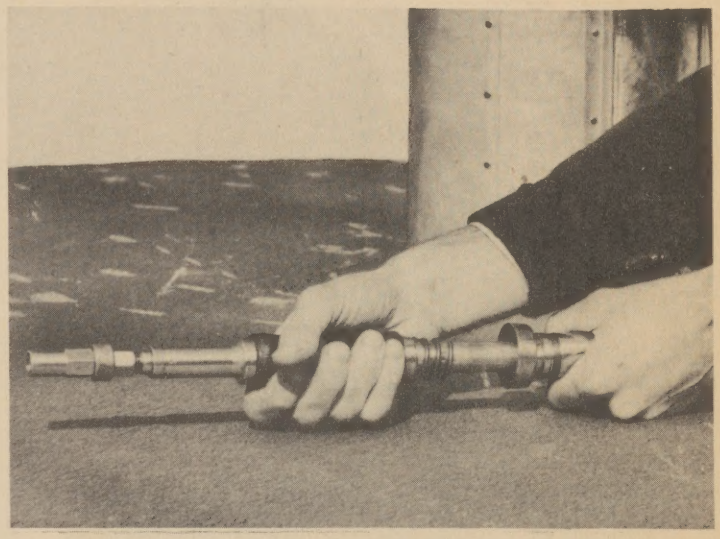
Anopheline larva: rests parallel to the water surface



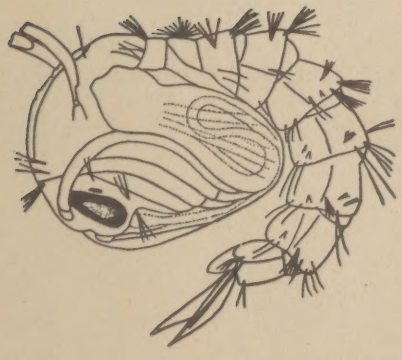
Trombone-type knapsack sprayer



Culicine larva: rests head downward from the water surface



Detail of the pump of the trombone-type sprayer

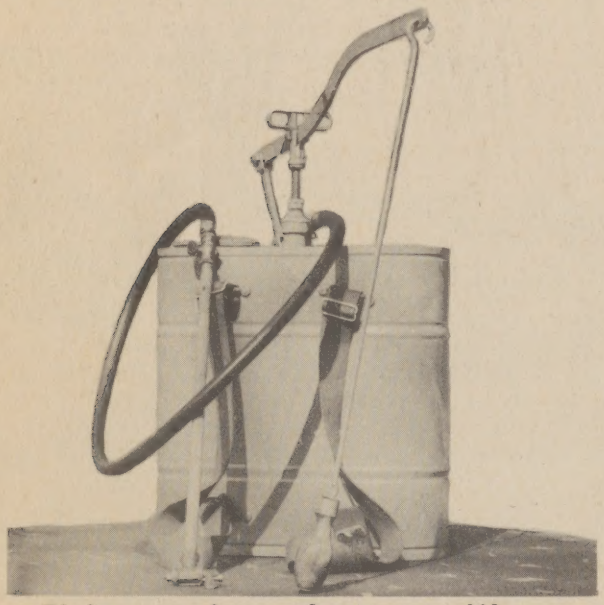


A mosquito pupa

Trombone-type sprayer in use

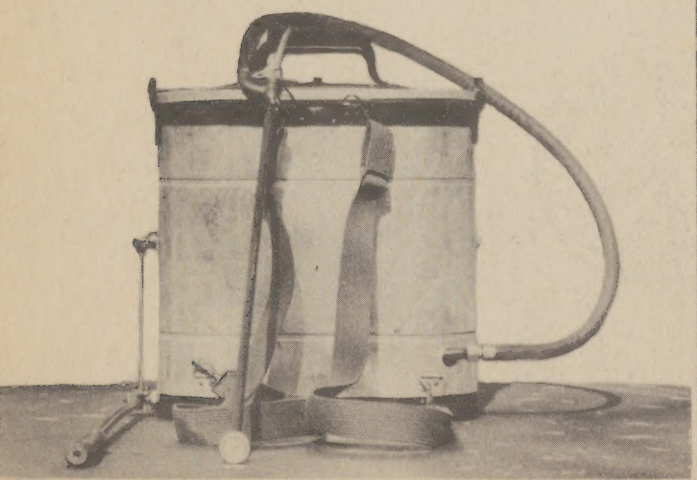
Compressed air sprayer --

--- in use

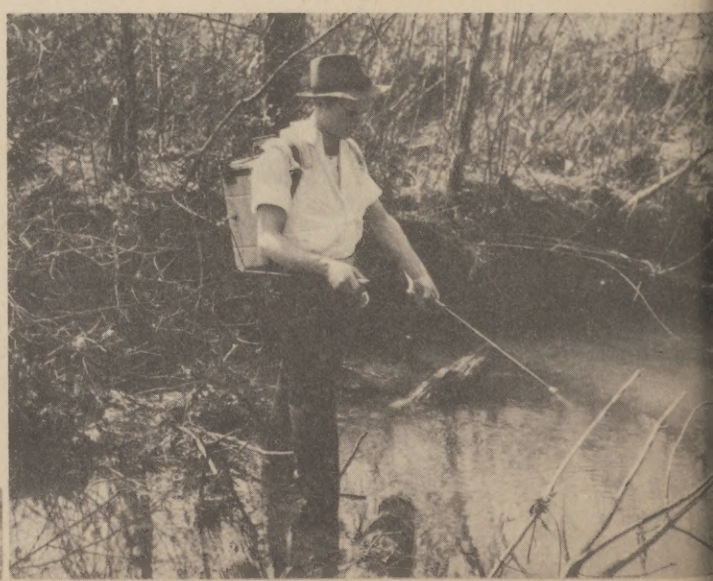


Piston pump knapsack sprayer with
over-the-shoulder pumping lever --

--- in use



Diaphram pump knapsack sprayer with
underarm pumping lever --



--- in use